Missouri Tributaries Basin

The Missouri Tributaries Basin (Basin) in Nebraska is defined as the areas of Nebraska that drain into the Missouri River between its confluence with the Niobrara River and its confluence with the Platte River and includes the Missouri River, Figure MT-1. Major streams in the Basin include Ponca, Bazile, Aowa, Elk, Omaha, Blackbird, and Papillion Creeks and the Missouri River, Figure MT-2. The total area of the Basin is approximately 3,000 square miles and includes all of Dakota County and portions of Antelope, Burt, Cedar, Dixon, Douglas, Knox, Pierce, Sarpy, Thurston, and Washington counties. County seats in the Basin include Blair, Center, Dakota City, Hartington, Omaha, Papillion, Ponca, and Tekamah.

Source of Water

Precipitation

Annual and growing season (May 1 through September 30) precipitation charts for gage sites in Blair, Butte, Hartington, Homer, Newcastle, and Omaha are shown on Figures MT-3 through MT-14. The average annual precipitation ranges from 23.7 inches at Butte near the northwestern end of the Basin to 30.3 inches at Omaha in the southeast corner of the Basin. The average growing season precipitation ranges from 15.5 inches at Butte to 19.3 inches at Omaha. Locations of the precipitation gages can be seen in Figure MT-15.

Water is also supplied to the Missouri River from surface water sources upstream from the Basin. These supplies far exceed the amount of water which originates locally and supplies the Missouri River.

Ground Water

The hydrogeology of the Basin is complex due to the glacial origin of the recent sediments. The entire Basin has been glaciated except for the western edge, Figure MT-

16. For purposes of this report, all saturated unconsolidated sediments of Quaternary age above bedrock inclusive of the paleovalley alluvial aquifers, the Missouri alluvial aquifers and the shallow aquifers and the bedrock Tertiary Ogallala Group are combined into the principal aquifer unit for the Basin. Secondary aquifers are made up of the remaining bedrock aquifers. Tables MT-1 and MT-2 list the aquifers by age with the important hydrogeologic characteristics. The bedrock aquifers range in age from Tertiary to Cambrian, Figure MT-17. The bedrock aquifers supply a small amount of water compared to the other aquifers but are an important source locally (CSD, 2005). They generally are not in hydrologic connection with the streams in the Basin.

The principal aquifer varies in saturated thickness from 0 to approximately 500 feet, Figure MT-18. Depth to water from the land surface varies from 0 to more than 200 feet, Figure MT-19 (CSD 2005). Transmissivity values range from less than 20,000 gallons per day per foot (gal/day/ft) to more than 200,000 gallons gal/day/ft. Most areas of the Basin have transmissivity values of less than 20,000 gal/day/ft, Figure MT-20. Areas of higher transmissivity are generally related to the paleovalley and Missouri River alluvial aquifers. Specific yield ranges from less than 5 to greater than 20 percent, Figure MT-21. Due to the glaciated nature of the area, the principal aquifer is not always hydrologically connected to the streams, except the Missouri River alluvial aquifers (CSD 2005). The ground water table, Figure MT-22, reflects the complicated nature of this glaciated area. Ground water tends to move from the uplands to the streams however the ground water contour map should not be taken as an expression of the hydrologic connection (CSD 2005).

Ground Water Use

Ground water in the Basin is used for a variety of purposes: domestic, industrial, livestock, irrigation, and others. There are 3,697 registered ground water wells within the Basin as of October 1, 2005 (Department registered ground water wells database). Not all wells are registered in the Department database, especially stock and domestic wells, which if drilled prior to 1993 are not required to be registered. Certain dewatering and

other temporary wells are not required to be registered. Irrigation is the largest consumer of ground water, with approximately 230,000 acres being supplied with water from approximately 1,600 wells as of October 1, 2005 (Department registered ground water wells database).

Ground water development is limited within the Basin by the geology of the area. Figure MT-23 illustrates the location of depletive ground water wells. The limited areal extent of those wells indicates where ground water has been beneficially developed. Most wells are found in the paleovalley and Missouri alluvial aquifers. Ground water development analyzed by comparison of completion dates has shown that development of high capacity wells (depletive wells capable of pumping more than 50 gallons per minute) has been steadily increasing with accelerated increases during the years 1967 through 1981 and 1994 to the present, Figures MT-24, MT-25, and MT-26. Table MT-3 shows the estimated average irrigated acreage by county within the Basin between 1950 and 2003. The increase in the number of other depletive wells seen in Figures MT-25 and MT-26 after 1993 is attributed to revision of the well registration statute in 1993.

Changes in Ground Water Table Elevation

Figure MT-27 is a map made from a compilation of all ground water table elevations reported to the Conservation and Survey Division of the University of Nebraska-Lincoln in cooperation with the U.S. Geological Survey and the Natural Resources Districts. It shows a small area in Cedar and Dixon counties with a small decline in ground water table elevations from predevelopment through the spring of 2005. Figure MT-28 is the location map for selected ground water hydrographs across the Basin. Figures MT-29 through MT-33 are hydrographs (USGS 2005) which give a representative change in ground water table elevations for the particular area. Where possible a graph of a continuous recorder site is used.

Ground Water Management

The Basin primarily encompasses portions of two Natural Resources Districts (NRDs): the Lewis and Clark NRD (LCNRD) and the Papio-Missouri River NRD (PMRNRD).

The LCNRD has established a ground water management area (GWMA) for quality purposes in the southwestern corner of the district within Knox County. As part of the GWMA requirements, permits are required prior to the construction of wells pumping greater than 50 gallons per minute (gpm). The PMRNRD has not established a GWMA.

Surface Water

Hydrographs from seven surface water gages in the Basin are included in this report, Figures MT-34 through MT-38. They are Bazile Creek near Niobrara, Omaha Creek at Homer, Tekamah Creek at Tekamah, and the Missouri River at Sioux City and Omaha, Figure MT-39. Streamflow in the Basin is primarily driven by precipitation and generally follows the annual variations in precipitation.

Surface Water Use

As of October 1, 2005, there are approximately 350 surface water appropriations in the Basin issued for a variety of uses. The majority of the appropriations are for irrigation use and they tend to be located on the major streams. There are no instream flow appropriations in the Basin. The first appropriations in the Basin were permitted in 1881 and development has continued through present day. The largest period of development occurred in the 1970's, Figure MT-40 and Figure MT-41. The approximate locations of the surface water diversion points are shown in Figure MT-42. Information on specific appropriations is available in the Department's biennial report. Information on categories of use can be found in Appendix H.

Analyses for the Fully Appropriated Determination

Surface Water Administration

In the 124-year period since the first surface water appropriation was perfected in the Basin, there is one recorded instance of surface water administration in the administrative record, occurring in 1988. A summary of water administration that occurred between 1985 and 2004 can be found in Table MT-4. The junior surface water appropriations in the Basin had an average of 62 days in which surface water was available for diversion from July 1 through August 31 and 153 days in which surface water was available for diversion from May 1 through September 30.

Table MT-4. Water Administration in the Missouri Tributaries Basin between 1985 and 2004.

Year	Water Body	Days	Closing Date	Opening Date
1988	Antelope Creek near Menominee		June 27	

The senior surface water appropriation that caused administration in the Basin has a priority date year prior to 1985; therefore it is not necessary to reconstruct the water administration table.

Determination of Hydrologically Connected Area

No sufficient numeric ground water model is available in the Missouri Tributaries Basin to determine the 10/50 area or the lag impact of ground water wells.

The Jenkins method can only be applied where sufficient data and appropriate hydrogeologic conditions exist. In most of the Basin the principal aquifer is absent or very thin due to the glaciated nature of the area (CSD 2005). Additionally, where there is a principal aquifer present, the complex hydrogeologic nature of this area makes the degree of connection between the ground water system and the surface water system poor and uncertain (CSD 2005). The area surrounding Bazile Creek is the only portion of the

Basin where the principal aquifer is present and in hydrologic connection with the streams (CSD 2005). Figure MT-43 shows the hydrologically connected area for the headwaters of Bazile Creek in accordance with Department rule 457 NAC 24.001.02 (Appendix A).

Lag Impacts

a) Current Well Development

The lag impact was computed using the Jenkins methodology documented in Appendix D. The results show that an additional 2 cubic feet per second (cfs) of daily depletion from ground water pumping to Bazile Creek can be expected in the year 2030 from the Basin due to the lag impact of existing wells if there is no new well development. At the present time, there is no way to quantify the effect the additional depletion will have on existing surface water appropriations in the Basin. Other information suggests that the current well development has a minimal impact on the long term streamflow. Many high capacity ground water wells have been completed in the Basin in the last 40 years, but there are no large areas of ground water decline and the observed decreases in streamflow appear to be mostly due to cyclical climatic conditions.

b) Future Well Development

Estimates of the number of high capacity wells that would be completed over the next 25 years if no new legal constraints were imposed on the construction of such wells were calculated based on extrapolating the present day rate of increase in well development into the future, Figure MT-44. For the past 20 years, the rate of increase in high capacity wells is nearly linear at a rate of 33 wells per year.

The lag impact was computed for the projected wells using the Jenkins methodology documented in Appendix D. The results show that an additional 5 cfs of daily depletion to Bazile Creek from ground water pumping can be expected in the year 2030 from the

Basin, if there is additional well development. As with the current well development analysis, there is no way to quantify the impact the additional depletion will have on existing surface water appropriations in the Basin. Other information suggests that the current well development has a minimal impact on the long term streamflow. Many high capacity ground water wells have been completed in the Basin in the last 40 years, but there are no large areas of ground water decline and the observed decreases in streamflow appear to be mostly due to cyclical climatic conditions.

Future Surface Water Development and Uses

The number of surface water appropriations in the Basin has grown steadily over the past 30 years and it appears appropriate to project that that trend will continue into the future, Figure MT-40. The number of acres permitted for surface water irrigation also has grown steadily for the past 30 years, Figure MT-41, and no significant changes to that rate of growth are expected in the future.

Ability to Satisfy Net Corn Crop Irrigation Requirement

Figure MT-45 shows the net corn crop irrigation requirement for the Missouri Tributaries Basin. The map shows the net corn crop irrigation requirement to be 9.0 inches or less for the entire Basin. Assuming a surface water diversion rate equal to 1 cubic foot per second per 70 acres and a downtime value of 10 percent; depending on the location in the Basin, it takes approximately 23.9 days annually to divert 65% of the net corn crop irrigation requirement from July 1 through August 31 and approximately 31.3 days to divert 85% of the net corn crop irrigation requirement from May 1 through September 30.

The surface water administration analysis showed 62 days in which surface water was available for diversion from July 1 through August 31 and an average of 153 days in which surface water was available for diversion from May 1 through September 30. The number of days in which surface water was available for diversion in both the July 1

through August 31 and the May 1 through September 30 time frames far exceed the required number of days for the Basin during those same periods.

Sufficiency of Surface Water Supply [Nebraska Revised Statutes Section 46-713(3)(a) (Reissue 2004)]

The average number of days surface in which surface water was available for diversion in both the July 1 through August 31 and the May 1 through September 30 time frames required by Department rule 457 Nebraska Administrative Code (NAC) 24.001.01 exceeds the number of days surface water is required to be available pursuant to the rule during those same periods. Because the average annual number of days in which surface water was available for diversion far exceed the number of days required (62 available versus 23.9 needed and 153 available versus 31.3 needed) it is unlikely that the existing level of well development will cause flows in the streams of the Basin to fall to the point where they may become fully appropriated without the initiation of additional uses. Table MT-5 summarizes the results of comparisons between the number of days surface water must be available to meet the 65% and 85% net corn crop irrigation requirements and the number of days in which surface water was available for diversion to the junior surface water appropriations.

Table MT-5. Summary of Comparison Between Net Corn Crop Irrigation Requirement and Number of Days Surface Water is Available for Diversion.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Annual Number of Days Available to the Junior Surface Water Appropriations (1985-2004)	Average Annual Number of Days Available in 2030 with no Additional Well Development	Average Annual Number of Days Available in 2030 with Additional Well Development
July 1 – August 31	23.9	62 (38.1 days above the requirement)	Not Calculated*	Not Calculated*
May 1 – September 30	31.3	153 (121.7 days above the requirement)	Not Calculated*	Not Calculated*

* This number was not calculated. Because the number of days in which surface water was available for diversion far exceed the number of days necessary to meet the net corn crop irrigation requirement, the final conclusion would not change even with the addition of lag impacts from additional wells.

Sufficiency of Streamflow for Ground Water Supply [Nebraska Revised Statutes Section 46-713(3)(b) (Reissue 2004)]

Since the criteria for Nebraska Revised Statutes Section 46-713(3)(a) were satisfied, the conclusion for this section is the same for reasons explained in the report introduction.

Sufficiency of Surface Water Supply for Compliance with Compacts or State Laws [Nebraska Revised Statutes Section 46-713(3)(c) (Reissue 2004)]

There are no compacts on any portions of the Missouri Tributaries Basin in Nebraska.

Future Development of Surface and Ground Water [Nebraska Revised Statutes Section 42-713(1)(b) (Reissue 2004)]

Given the rate of registered ground water well and surface water appropriation development, the conclusion that the Basin is not fully appropriated would not change even if no additional legal constraints were placed on development and a reasonable

projection of a continuation of the current trend of well development of the last 20 years is used.

Conclusions

There is no evidence that current ground water depletions to streamflow in the Basin are affecting surface water users sufficiently to meet the criteria for being fully appropriated as found in Department rule 457 NAC 24.001.01 when compared to the amount of surface water available at the present time.

There is no evidence available at this time that lag impact will be sufficient in 25 years to affect existing water users enough to meet the criteria for being fully appropriated as found in Department rule 457 NAC 24.001.01.

Based upon available information and its evaluation, the Department has reached a determination that the Basin is not fully appropriated. The Department has also determined that even if no additional legal constraints are imposed on future development of hydrologically connected surface water and ground water and reasonable projections are made about the extent and location of future development, this conclusion would not change.